Nano- and Microcrystalline Diamond Grown in High-Electron Density Plasma of Millimeter Wave CVD Reactor

Vikharev A.L.

Institute of Applied Physics, Nizhny Novgorod, Russia
val@appl.sci-nnov.ru

The results of investigations of nanocrystalline and microcrystalline diamond film deposition in novel microwave plasma-assisted CVD reactor based on 10 kW gyrotron operating at frequency 30 GHz are presented. Recently high-electron-density plasma generated by the millimeter-wave power was suggested for enhanced-growth-rate CVD [1]. The influence of increasing the operating frequency of microwaves in CVD reactor that exceeds the conventionally used frequency 2.45 GHz on diamond deposition process is discussed. For understanding of growth conditions the investigations of the plasma parameters (electron density and gas temperature) in novel CVD reactor are presented.

Nanocrystalline and microcrystalline diamond films were grown on silicon substrates with 60-90 mm diameter. The growth rate of diamond films, their quality and morphology at wide variation of process parameters (methane concentration, gas pressure, substrate temperature, microwave power) in gas mixture $Ar/H_2/CH_4$ were investigated. The content of methane (CH_4/H_2) in the gas mixture was varied in the range from 1% to 30%, and that of argon (Ar/H_2+Ar) from 50% to 99%, while the total gas flow was 400 sccm. The 30 GHz CVD reactor was operated across a range of the gas pressure from 100-400 Torr and input microwave power from 4 to 10 kW. The conditions of high quality microcrystalline diamond films growth with deposition rate up to 15 micron per hour were found. The diamond films were characterized using Raman spectroscopy, atomic force microscopy, optical and scanning electron microscopy.

[1] A.L. Vikharev et al., *Diamond and Related Materials* **15**, 502 (2006).